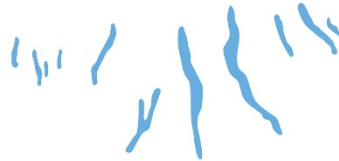


Ecology of Cyanobacteria

Lisa B. Cleckner, Director
cleckner@hws.edu

September 30, 2017

FINGER LAKES
INSTITUTE



HOBART AND WILLIAM SMITH COLLEGES

Finger Lakes Institute @ HWS

Research



Education



Outreach



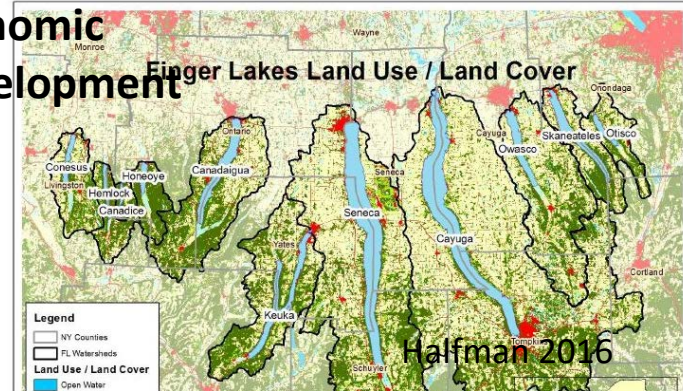
STOP THE SPREAD

THE FINGER LAKES PRISM

Working to reduce the introduction, spread, and impact of invasive species throughout our region.



Economic Development



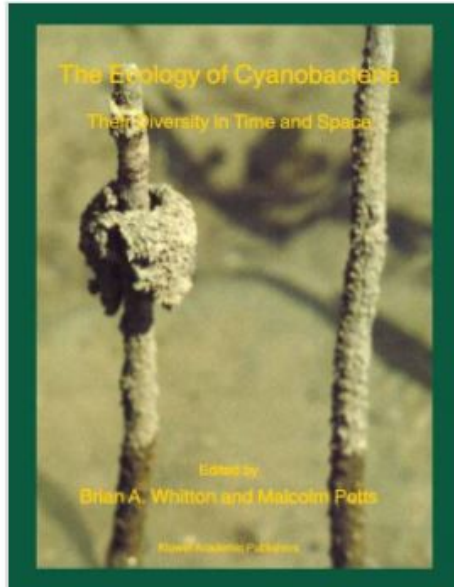
<http://www.fingerlakesustainablefarming.org/>

Outline of Presentation

- Finger Lakes Context
- Cyanobacteria history and competitive advantages
- Harmful Algal Blooms in NY, FLI projects
- Climate change

Ecology of Cyanobacteria

- Enormously large topic



ABOUT

AFFILIATION

DISCIPLINES

EDITORS Brian A. Whitton • Malcolm Potts

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ISBN 9780306468551 (online) • 9780792347354

IMPRINT Springer Netherlands

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Reflections on O₂ as a Biosignature in Exoplanetary Atmospheres

Journal article in **Astrobiology**

Palm oil mill effluent treatment and CO₂ sequestration by using microalgae? sustainable strategies for environmental protection

Journal article in **Environmental Science and Pollution Research**

Cyanotoxins: producing organisms, occurrence, toxicity, mechanism of action and human health toxicological risk evaluation

Journal article in **Archives of Toxicology**

Adaption of Microbial Life to Environmental Extremes

Book with ISBN **9783319483252**

The use of NH₄⁺ rather than NO₃⁻ affects cell stoichiometry, C allocation, photosynthesis and growth in the cyanobacterium *Synechococcus* sp. UTEX LB 2380, only when energy is limiting

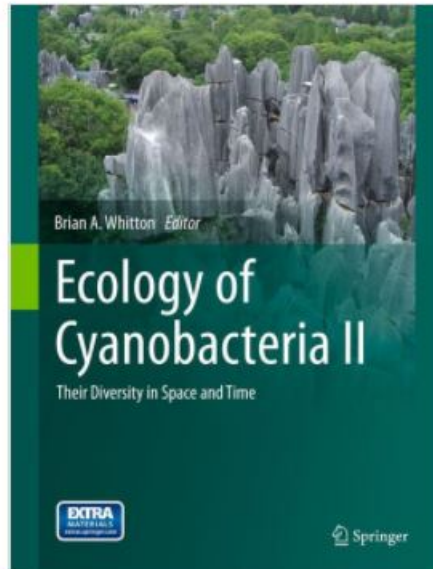
Journal article in **Plant, Cell & Environment**

Diversity and Biomineralization Potential of the Epilithic Bacterial Communities Inhabiting the Oldest Public Stone Monument of Cluj-Napoca (Transylvania, Romania)

Journal article in **Frontiers in Microbiology**

Cover and citation info courtesy of
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Ecology of Cyanobacteria II



ABOUT

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1 2 3 4 5

2017

Modern Topics in the Phototrophic Prokaryotes

Book with ISBN 9783319462592

Handbook of Cyanobacterial Monitoring and Cyanotoxin Analysis

Book with ISBN 9781119068761

Handbook of Cyanobacterial Monitoring and Cyanotoxin Analysis

Book with ISBN 9781119068761

Cyanobacterial Diversity in Microbial Mats from the Hypersaline Lagoon System of Araruama, Brazil: An In-depth Polyphasic Study

Journal article in *Frontiers in Microbiology*

UV-C as an efficient means to combat biofilm formation in show caves: evidence from the La Glacière Cave (France) and laboratory experiments

Journal article in *Environmental Science and Pollution Research*

Single colony genetic analysis of epilithic stream algae of the genus *Chamaesiphon* spp.

Journal article in *Hydrobiologia*

Effect of glacial lake outburst floods on the light climate in an Andean Patagonian lake: Implications for planktonic phototrophs

Journal article in *Hydrobiologia*

Cover and citation info courtesy of
bookmetrix.com

Harmful Algal Blooms – Ohio, 2014



Toledo Blade

- Drinking water
- August weekend
- ~500,000 people impacted
- Toxin-producing

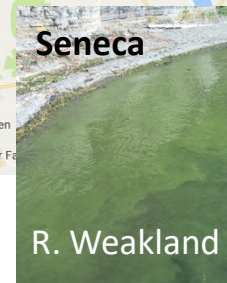
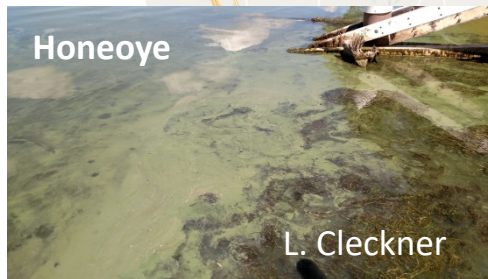
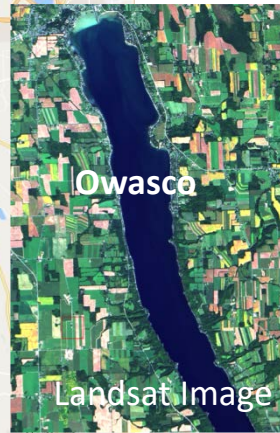
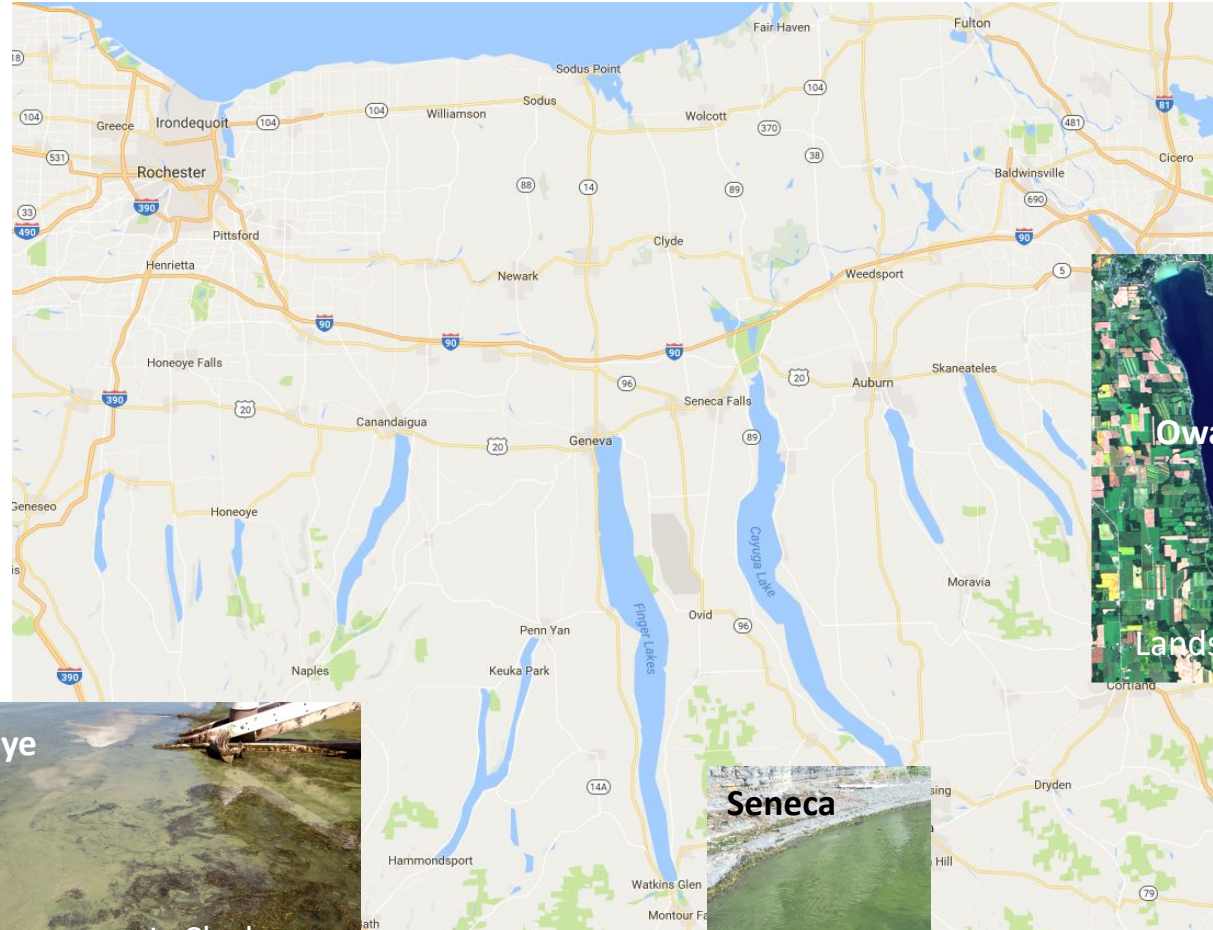


Satellite image of 2013 intense bloom, which was concentrated in the lake's western basin. (Click for a high resolution image. Credit: MODIS/NASA, processed by NOAA/NOS/NCCOS)

Harmful Algal Blooms (HABs) in FL ('12 – '16)

Lake	'12	'13	'14	'15	'16
Conesus					
Hemlock					
Canadice					
Honeoye					
Canandaigua					
Keuka					
Seneca					
Cayuga					
Owasco					
Skaneateles					
Otisco					

Suspicious
Confirmed
High Toxin

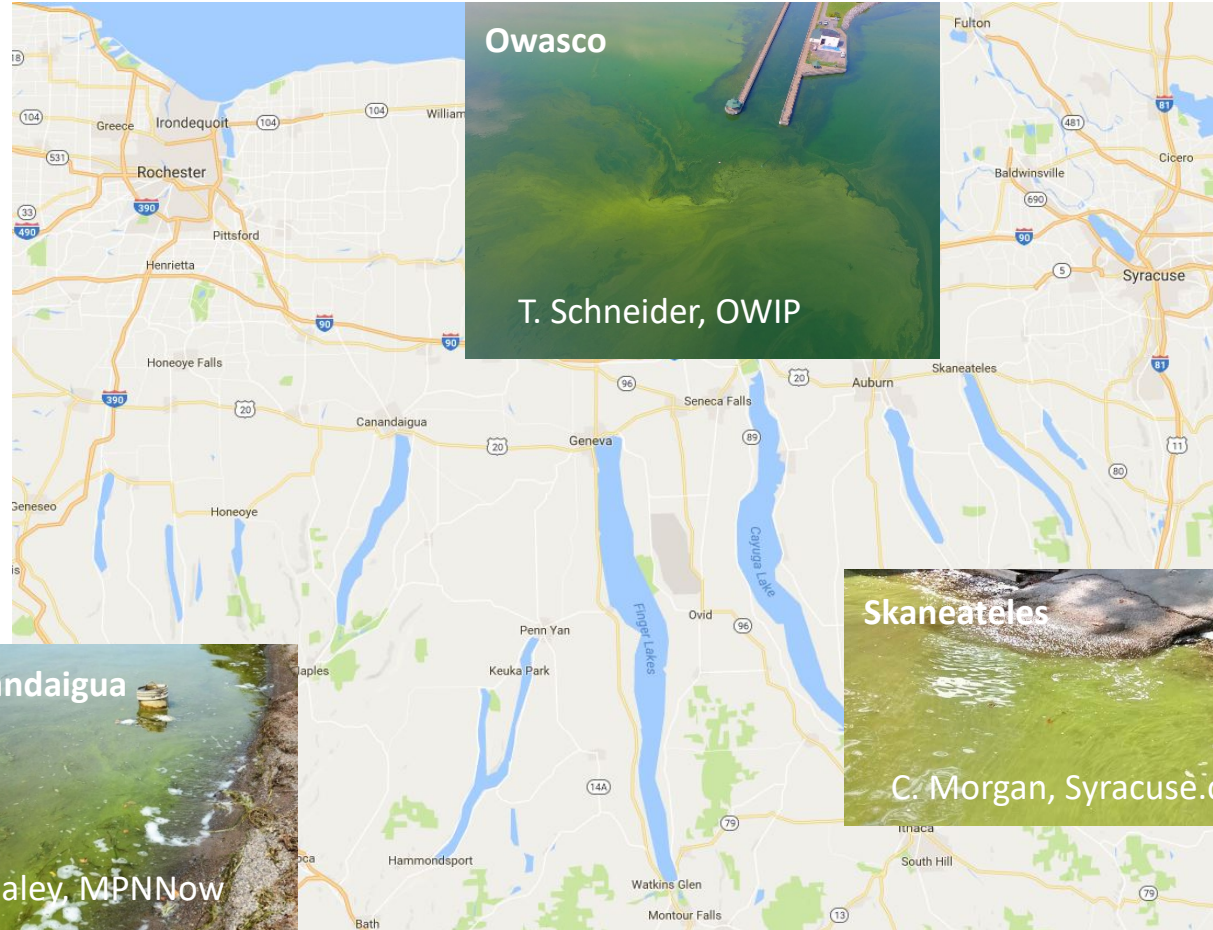


http://www.dec.ny.gov/docs/water_pdf/habsextentsummary.pdf

Harmful Algal Blooms (HABs) in FL ('17)

Lake	'12	'13	'14	'15	'16	'17
Conesus						
Hemlock						
Canadice						
Honeoye						
Canandaigua						
Keuka						
Seneca						
Cayuga						
Owasco						
Skaneateles						
Otisco						

Suspicious
Confirmed
High Toxin



HABs

Harmful – Toxins present at high concentrations

Algal – Ironically, not algae, but rather Cyanobacteria

Blooms – High concentrations

Checklist

- ✓ Sun
- ✓ Nutrients
- ✓ Warm temperatures
- ✓ Little wind

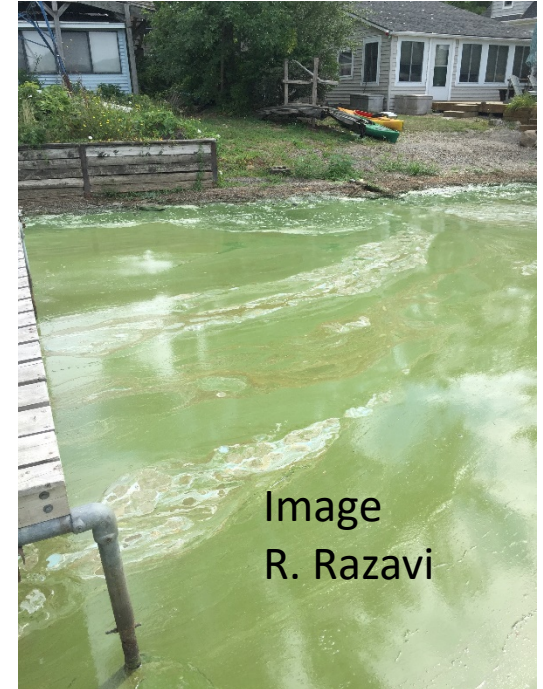
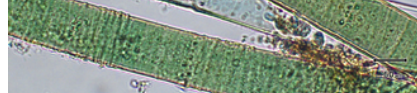
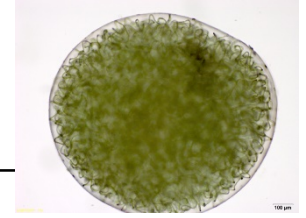
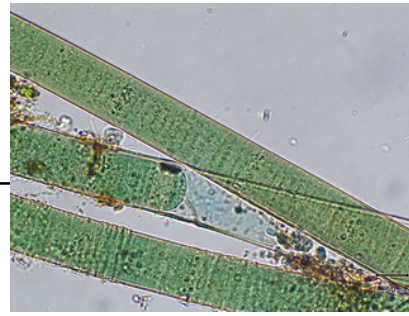


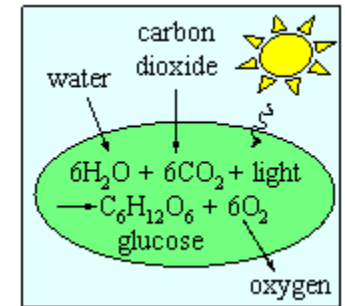
Image
R. Razavi

Cyanobacteria

- 3.5 billion years old
 - Dominant life form for ~1.5 billion years
 - Prokaryotes
 - Diversity of environments
 - Hot springs, cycads, polar
 - Base of aquatic food web for energy /nutrient flows – autotrophs
- 
- Images from
UNH Phycok



Images from
UNH PhycoKey

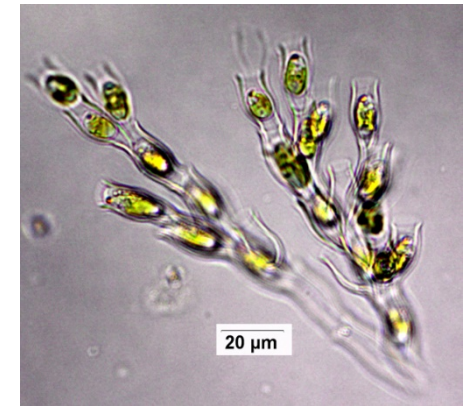
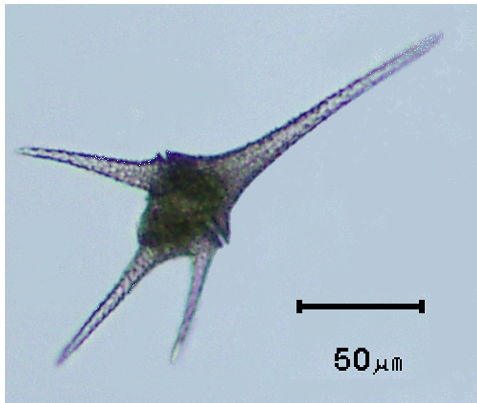
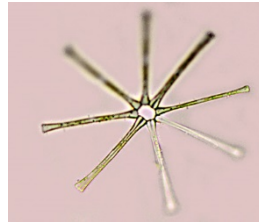
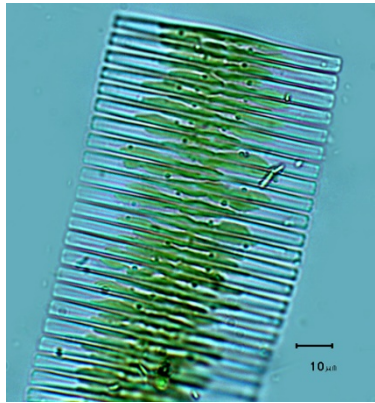


“The breathable air we enjoy today originated from tiny organisms, although the details remain lost in geologic time.”

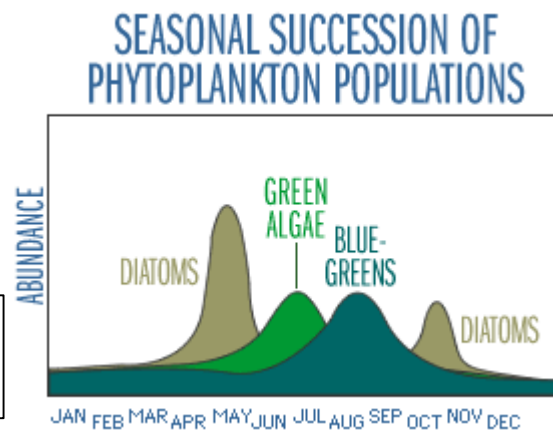
David Bello, 8/19/09, Scientific American

<https://www.scientificamerican.com/article/origin-of-oxygen-in-atmosphere?>

Phytoplankton Community - Algae

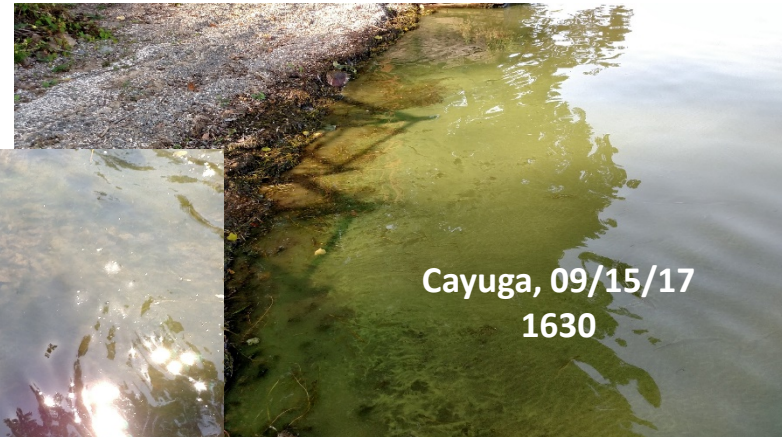


Images courtesy of Water on the Web, UNH PhycoKey



Cyanobacteria Survival Strategies — Gas Vacuoles

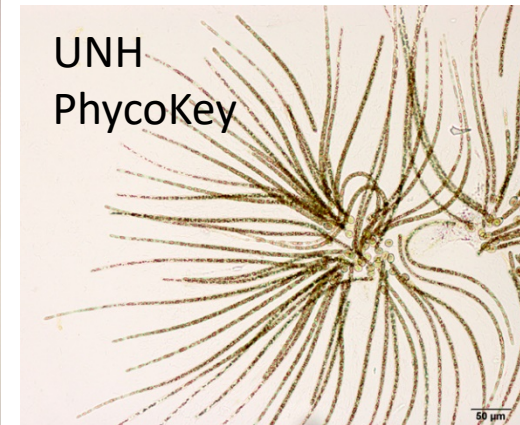
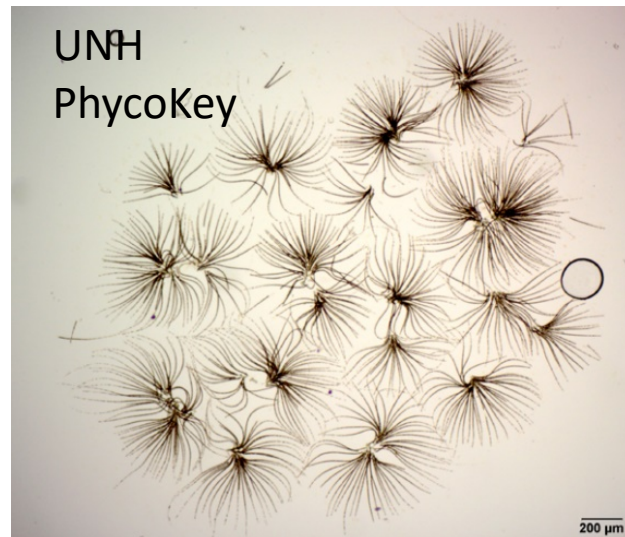
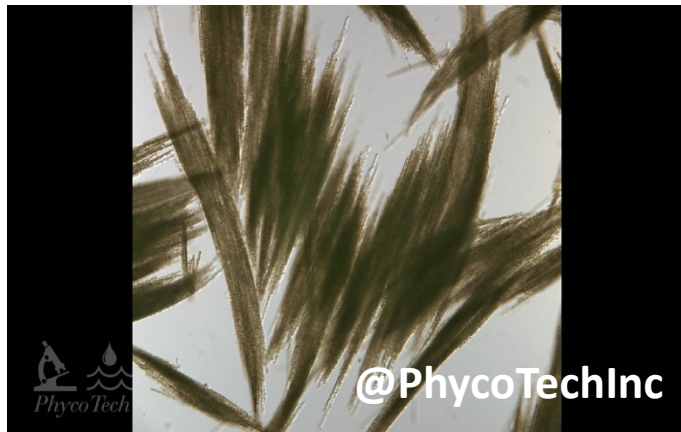
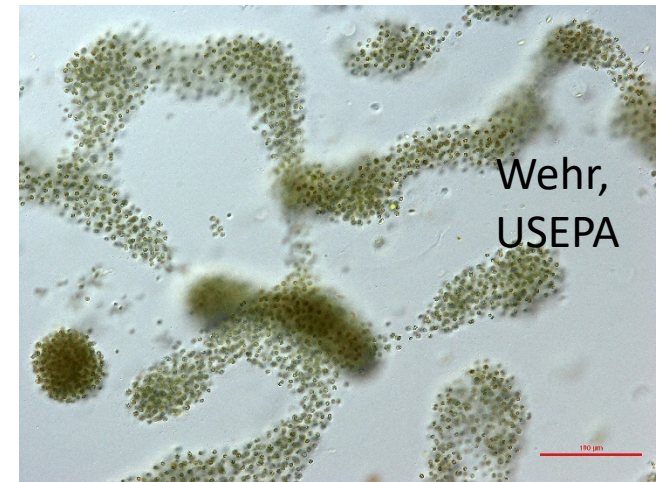
- Position optimally in water column
 - Light, Nutrients
- Shade other plankton
- For shallower waters/shorelines, can develop concentrated layers at the surface



Images: L. Cleckner

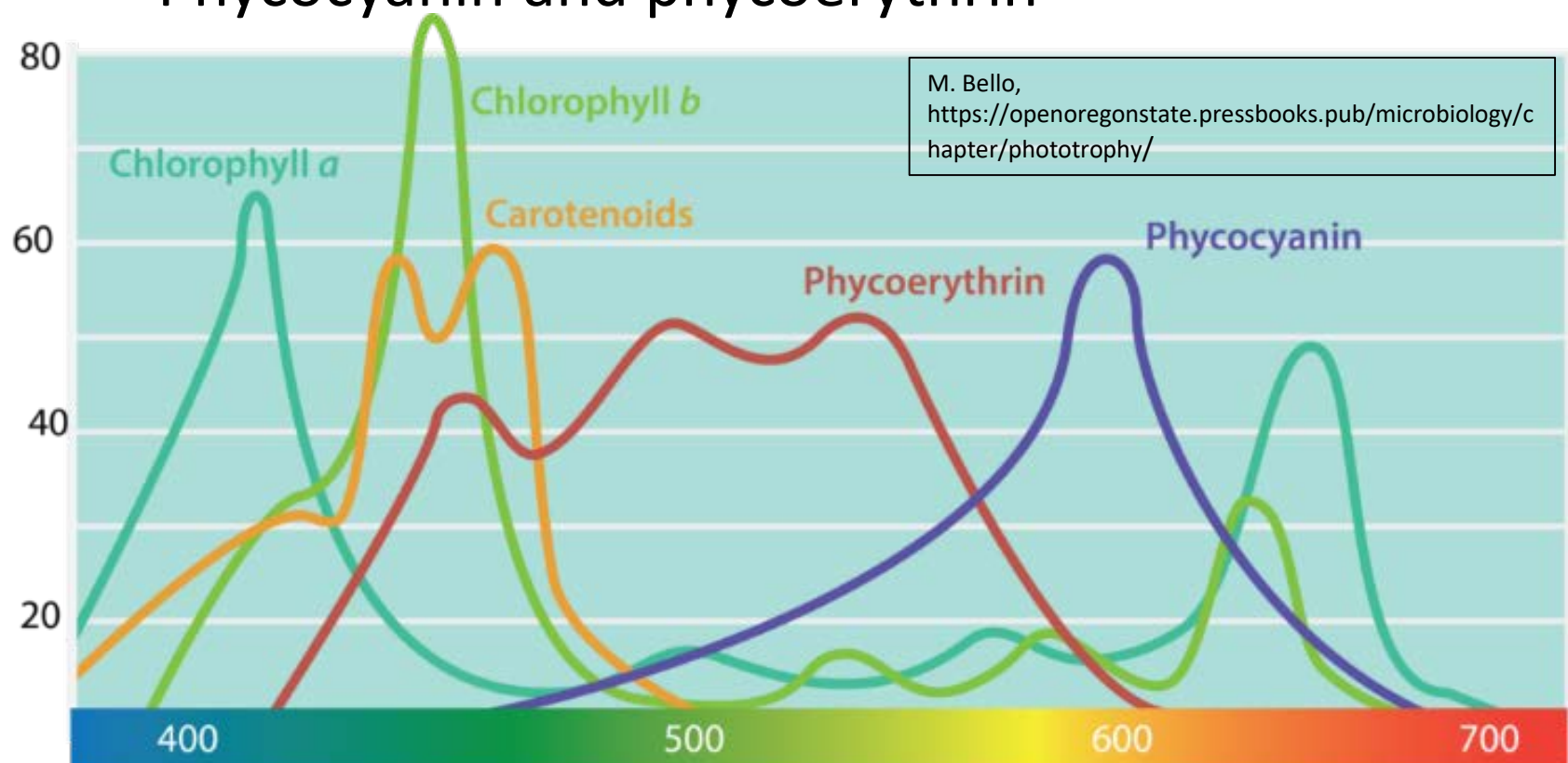
Cyanobacteria Survival Strategies - Morphology

- Colonial forms
- Mucilagenous sheath
 - Tough for invertebrates (filter feeders) to graze
 - Prevents desiccation



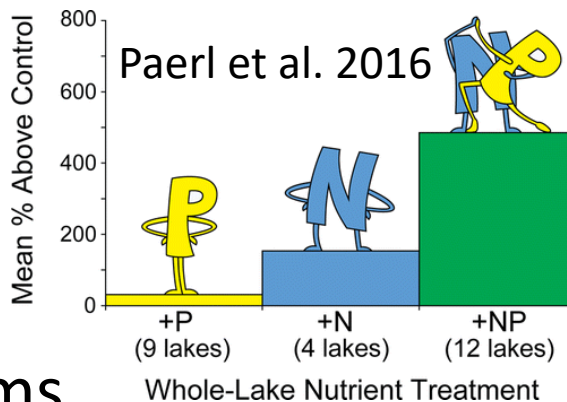
Cyanobacterial Survival Strategies – Low Light Levels

- Chl a and accessory pigments can use light from several wavelengths
 - Phycocyanin and phycoerythrin



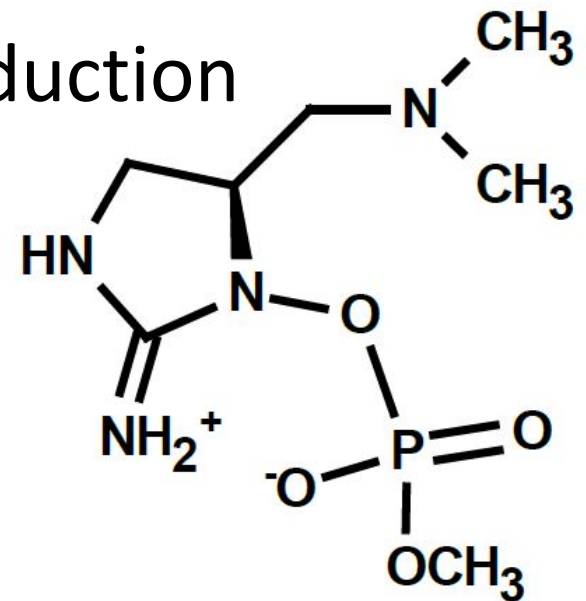
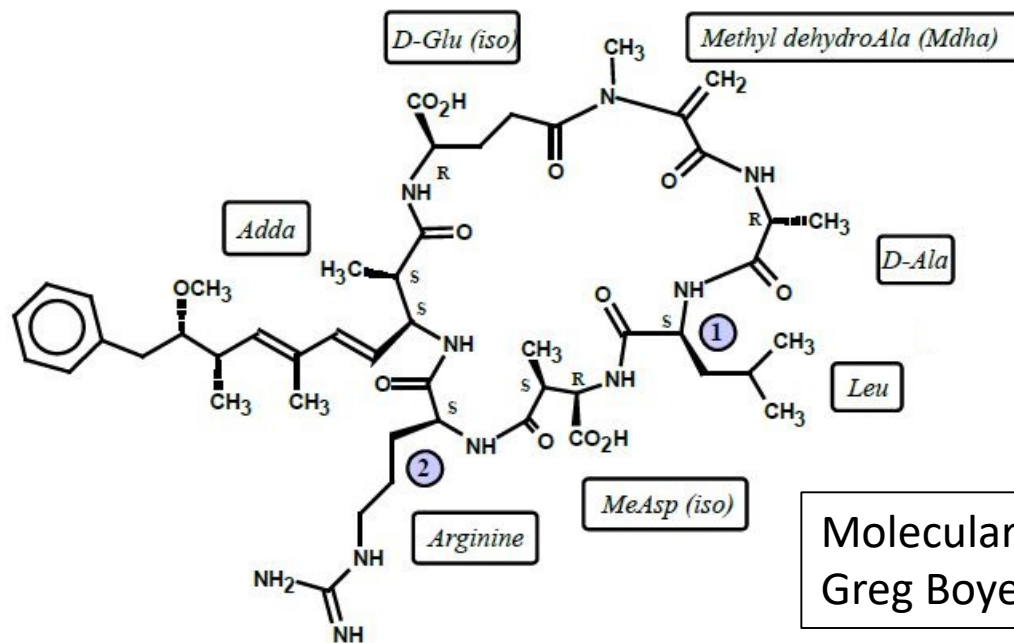
Cyanobacterial Survival Strategies – Nutrients

- Nitrogen fixation
- P limitation, but reduced forms of N are important for Cyanobacteria
 - NH_4 , urea
- Regeneration of nutrients in water column, sediments vs. introduction of new sources (streams, atmosphere)
 - Bacteria, plants, others
- Cause/effect of nutrient levels and types, plankton communities
 - Process level studies needed



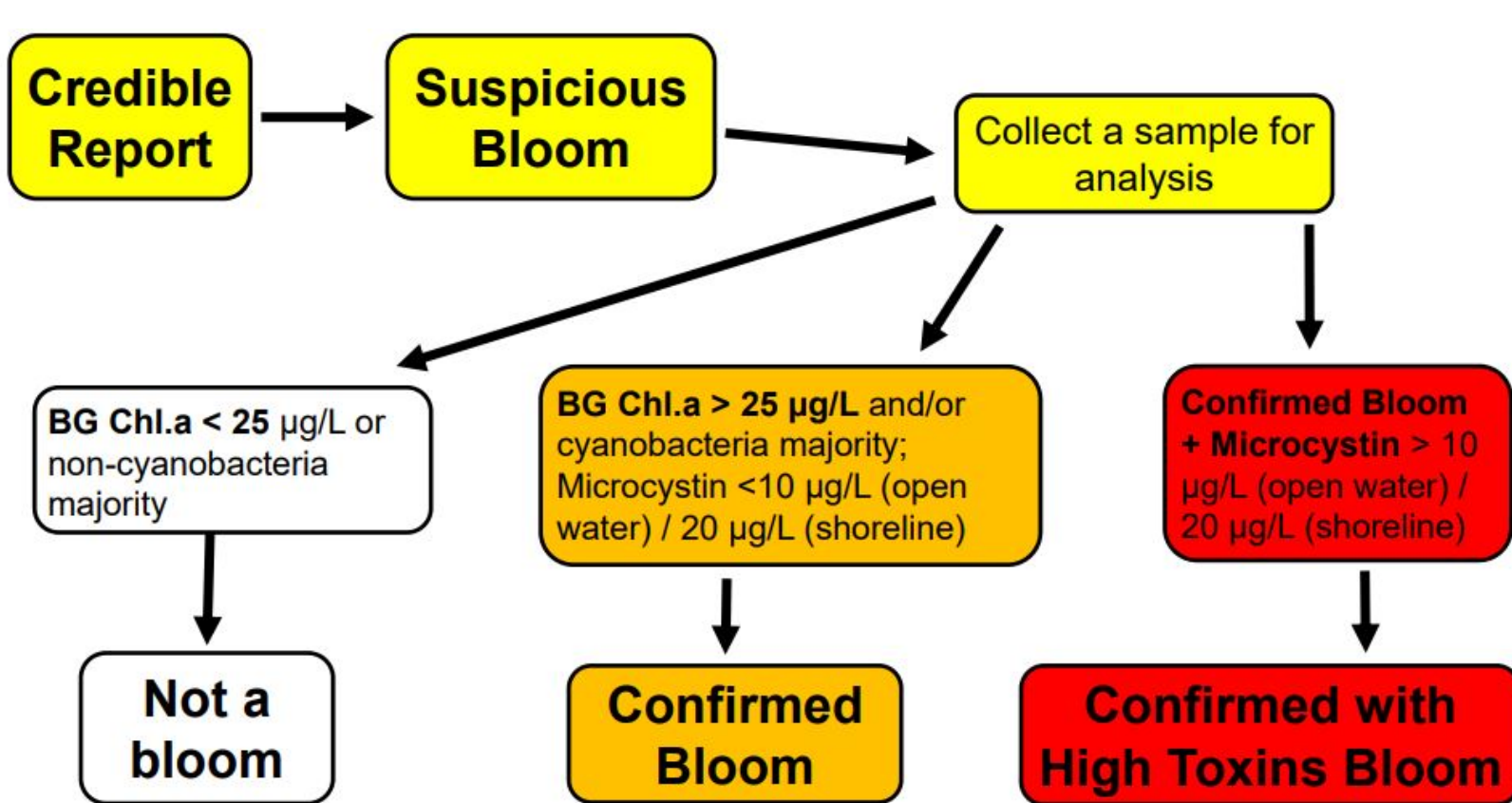
Survival Strategies – Toxin Production

- Discussed in next presentation
 - Not all species all the time
- Many compounds, analytical methods
- Role that genes, N play in production



Molecular Structure Source:
Greg Boyer, SUNY ESF

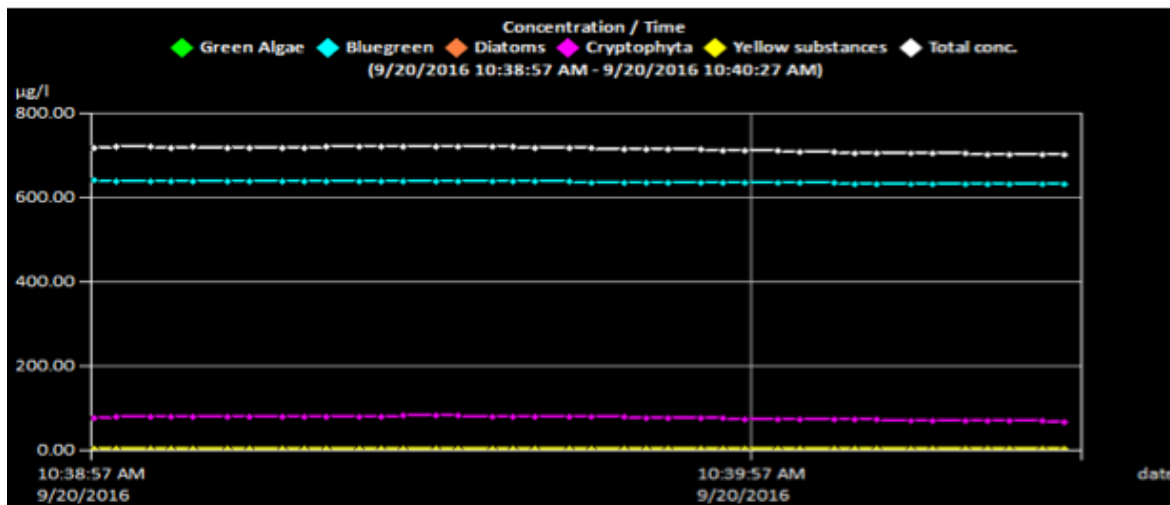
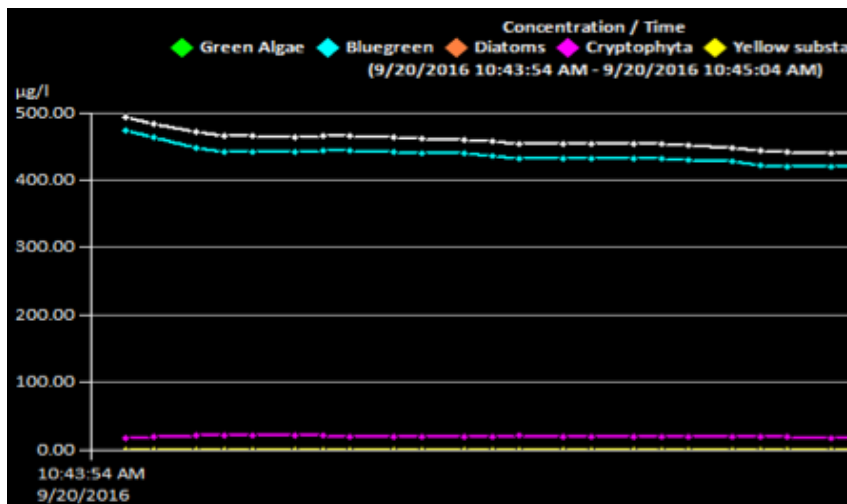
Cyanobacteria and HABs in NY



Source: Rebecca Gorney, NYSDEC



Seneca Lake HABs 09/19/16



More toxic algae on Seneca Lake

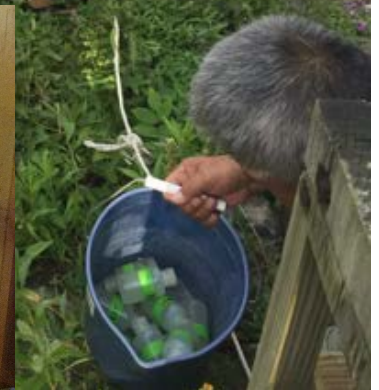


More toxic algae on Seneca Lake

SENECA LAKE--Following two confirmed cases of toxic algae on Seneca Lake in August, one more location has tested positive for potentially harmful algae. Lake water samples taken Sept. 19 at Kime Beach in Geneva have confirmed new blooms of cyanobacteria (commonly referred to as Blue-Green Algae (BGA) or Harmful Algae Blooms (HABs)) on Seneca Lake this season. This follows two weeks of no new reports of cyanobacteria blooms on the lake. The last such cyanobacteria blooms were reported the last week of August at Perry Point and the Hector shoreline. Hobart and William Smith College's Finger Lakes Institute (FLI) and SUNY College of Environmental Science and Forestry (SUNY ESF) tested the samples from two locations along Kime Beach and found levels of cyanobacteria that are considered harmful to people and animals in both samples. Several other visual reports of suspicious algae blooms have been reported from around the lake during this summer season.

<http://www.observer-review.com/more-toxic-algae-on-seneca-lake-cms-5465>

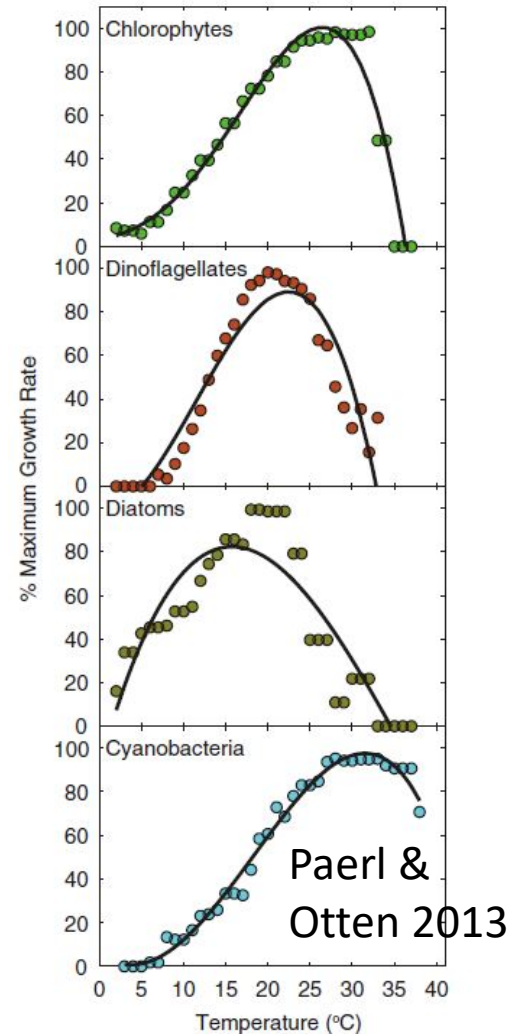
Project: Nitrogen and HABs in Honeoye L.



HABs, Climate Change, Our Future

- Temperature
- Precipitation
 - Delivering more nutrients from watershed
 - Timing of events?

T. Casella, Cayuga Lake
2/24/17



Conclusions

- HAB organisms are ancient, well adapted
 - Competitive advantages over other phytoplankton groups esp. in late summer
- Climate change will exacerbate occurrence of HABs in future
- Further study
 - Sources and regeneration of nutrients
 - Occurrence of HABs in low nutrient lakes?
 - Role of plants, benthic algae, invasive species communities
 - Omics applications